TWIN HYBRIDS FROM CROSSES OF ŒNOTHERA LAMARCKIANA AND FRANCISCANA WITH Œ. PYCNOCARPA, IN THE F_1 AND F_2.

(Plates I–IV.)

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The peculiar behavior of *Œnothera pycnocarpa* and *Œ. nutans* in reciprocal crosses[1] (Atkinson, 1917) led me to undertake reciprocal crosses of these with other species of Œnothera. Among the species which were used more attention has been given to *Œnothera lamarckiana* and *Œ. franciscana.*[2] Seed of the former was obtained from de Vries, of the latter from H. H. Bartlett.

Reciprocal crosses of these two species with *Œnothera nutans* gave results which indicated that twin hybrids were produced in the F_1. The plants were grown as annuals in 1915, so that the observations were made on summer rosettes and on the mature plants. The number of individuals in some of these crosses was few. The broad leaves of *Œ. nutans,* however, resembling in general form and size those of *Œ. lamarckiana* and *franciscana,* made an analysis of the results more difficult and uncertain than in the reciprocal crosses when *Œ. pycnocarpa* was used, since its rosette leaves are narrow and deeply cut over the proximal half.

This paper, therefore, treats only of the reciprocal crosses of *Œ. lamarckiana* and *franciscana,* with *Œ. pycnocarpa.* The pollinations for the reciprocal crosses were made during the season of 1914. The seeds were sown in March, 1915, transplanted to flats or pots in April, and then transplanted to the garden in June. The season was quite rainy until the latter part of August and in Sep-

[1] These œnothera studies were undertaken more from the morphological standpoint than from that of plant breeding.

[2] *Œnothera franciscana* Bartlett, *Rhodora,* 16, 35, 1914. This species, like *Œ. lamarckiana,* is one of the large-flowered, open pollinated species.

tember. A very few of the plants did not pass beyond the rosette stage, and as there were a number in which stem development began late in the season, it was possible to connect the types of rosettes with the types of mature plants.

Reciprocal Crosses of Œnothera lamarckiana and pycnocarpa.

Cultures of 1915, Annual.

Œnothera lamarckiana × *Œ. pycnocarpa* (*No. 99*).—Including those individuals which did not advance beyond the rosette stage there were between 80 and 90 plants in the F_1. There was a distinct splitting into two types, *i. e.*, twin hybrids were formed. In certain respects these twin hybrids agree with twin hybrids obtained by de Vries (1913) in crosses of *Œ. lamarckiana* with certain other species. In certain characters they resemble one of the parents but are modified by the other parent. I shall speak of them as the *pycnocarpa type* and the *lamarckiana type,* but there are such a number of strong contrast characters in the two species that the names of the types might with equal reason be reversed, depending on the form character chosen to represent the type. In this case the deeply cut feature of the rosette leaves, present in *pycnocarpa,* serves to mark the *pycnocarpa type,* while the nearly plain, or slightly toothed feature of the rosette leaves of *lamarckiana* serves to indicate the *lamarckiana type.*

Pycnocarpa Type; Rosettes.—A rosette of this type obtained in the 1915 cultures is represented in Fig. 1, Pl. 1. The pycnocarpa character, cutness of the basal half of the leaves is clearly seen, though they are not so deeply cut as in the rosette leaves of the parent (see Atkinson, 1917, p. 228, Fig. 13). The rosette is strongly modified, however, by the *lamarckiana* characters, convexity and crinkledness of the leaves, and the leaves are a little broader than those of *pycnocarpa.*

Pycnocarpa Type; Mature Plant.—There were 54 mature plants of this type in the culture. The width and edge character of the leaves come from *pycnocarpa.* They are long, narrow, more or less furrowed, and rather strongly toothed, more so over the base, as in *pycnocarpa.* The leaves are rather crowded and drooping, but are

more or less crinkled as in *lamarckiana*. The stem tubercles are red. The calyx bud is rather robust, about 3 cm. long by 7–8 mm. stout, tapering slightly, and then abruptly at the base of the tips, and there is considerable red in longitudinal bars. The flowers are large, up to 6.5 cm. broad; petals 25–30 mm. long and 30–35 mm. broad, broadly obovate and emarginate, overlapping or just closing the gap. The pod spikes are rather dense; the pods 3–3.5 cm. long and 6–7 mm. broad, often with red bars.

Lamarckiana Type; Rosettes.—No fully developed rosettes of the *lamarckiana* type appeared in this annual culture. The type of rosette, however, is shown in Fig. 1, Pl. I., from the F_2 culture. As a whole it resembles neither *lamarckiana* nor *pycnocarpa*. An analysis of the rosette, however, reveals a combination of *lamarckiana* and *pycnocarpa* characters. The edge character of the leaves, toothedness, is that of *lamarckiana,* while the narrowness, non-crinkledness and furrowedness are those of *pycnocarpa.*

Lamarckiana Type; Mature Plants.—There were 35 mature plants of this type in the culture. They agree with those of the *lamarckiana* type in the reciprocal cross. The plants (annuals) were 100–110 cm. high. The stems are green, with red tubercles, a few red tubercles also on the young ovaries. The foliage is rather light green. The leaves are rather narrow and long, over the middle part of the stem 15–17 × 3–3.5 cm., the edge only slightly toothed. The lower bracts are leaf like, sessile, up to 13 cm. long by 3.5 cm. broad. The calyx buds are usually green, but sometimes with a flush of red in spots, 3–3.5 cm. long by 8 mm. stout at the base, tapering gradually to the apex or somewhat abruptly contracted at the base of the tips. The buds and flowers are intermediate in size between the two parents; petals 32 × 30–40 mm. The pod spike is lax.

Œnothera pycnocarpa × *Œ. lamarckiana* (*No. 98*).—There were approximately 400 plants in this culture. There were 360 of the *lamarckiana* type, which agree in all respects with the *lamarckiana* type of the reciprocal cross. The remaining 39 plants presented two types of flowers, 34 with large flowers and a long fruiting spike 60–70 cm. long; bracts, especially the lower, large and leaf-like, no flush of red observed on the calyx bud, except rarely, the leaves

were strongly toothed, pod spike lax, and tubercles on the stem green. There were three plants distinctly of the *pycnocarpa* type with small flowers, but no red color was observed. All these 39 plants probably belong to the *pycnocarpa* type so far as the rosettes are concerned, as well as edge character of the leaves.

In all of the hybrid types it has been observed that the color is very variable, especially that of the calyx buds. Also it has been observed that there is a variation in size of the flowers, some of the plants having small flowers, others large. I have suspected that there was further splitting of the types in regard to flower size, but it was impossible with the amount of other work on hand to study flower size, or color behavior in either the F_1 or F_2 cultures. The studies have been confined largely to the rosettes, exclusively so in the F_2. It would be of interest, however, to study carefully flower and color behavior in the F_1 and F_2 hybrids.

One of the very marked differences between the two hybrid types is the length and general habit of the fruiting spike in the annual forms, and this feature in each twin is in strong contrast to the fruiting spikes of the parents. In the *pycnocarpa* type the density of the foliage and broader leaves, or lower bracts, contrast well with the open foliage and narrow leaves, or lower bracts, of the *lamarckiana* type. The relative width of the leaves, and their crinkled, or noncrinkled character, parallels these features in the rosettes of the twins. The differences in length of the fruiting spike were very striking in this annual culture. While this feature has not been carefully analyzed in biennial cultures, I doubt if the variation in biennial cultures is so great. Even in annual cultures I am inclined to believe that the results would vary to some extent with the season, and the time of the year when stem development began. In the reciprocal cross the same features were presented in the fruiting spikes of the twin hybrids.

Cultures of 1916: Biennial.

In the autumn of 1915 seed was harvested from protected plants, of parents, and twin hybrids of the reciprocal crosses except the *pycnocarpa* type of *lamarckiana* × *pycnocarpa*. The seed was planted in pans during April, 1916, transplanted to 2 inch, or 2½

inch pots in May, and from these set out in the garden in June. Of the 75–100 seedlings of each hybrid type of the reciprocal cross, 50 were transplanted to the garden. A few (12–15) of the parent *pycnocarpa* were grown for comparison, and about 150 of the parent *lamarckiana*. The object in growing them as biennials was to obtain the well-developed autumnal rosettes. In all of the cultures the rosettes were large, well developed and remarkably uniform except for an occasional mutant from the *pycnocarpa* type, and a few mutants from the parent *lamarckiana*.

The F_2 of the pycnocarpa type (pycno × lam) No. 155.—The *pycnocarpa* character, the cutness of the leaves over the basal half, is very pronounced, though it is not so strong as in the parent *pycnocarpa*. The convexity and crinkledness inherited from *lamarckiana* is very striking. The width of the leaves is greater than in the *lamarckiana* type. The type of rosette is well represented in the F_1 of the reciprocal cross (Pl. I, fig. 1).

The F_2 rosettes of the *pycnocarpa* type of the reciprocal cross (*lam* × *pycno*) were identical with those of the *pycno* × *lam* cross, and no photograph was made, but the form of the rosette of this type is shown in Pl. I, fig. 1.

While this hybrid type has been called the *pycnocarpa* type, the rosettes really show more of the *lamarckiana* character than they do of the *pycnocarpa* character. If these twin hybrids were to be named now, I should reverse the names because of the preponderance of *lamarckiana* characters in the rosettes of the *pycnocarpa* type, and the preponderance of *pycnocarpa* characters in the *lamarckiana* type. But as all my notes, numbers and marks on the negatives correspond to the names here employed, it does not seem wise to change at this time. In this connection it is of interest to note that the *pycnocarpa* type throws occasional mutants. The rosettes of the mutants which have thus far appeared are of two types. One appears to be a dwarf of the true *lamarckiana*. The other has very narrow, furrowed leaves, resembling in some respects the *lamarckiana* type of these twins, but is much smaller and the leaf edge rather strongly toothed the entire length. The *pycnocarpa* type of twin, in addition to presenting a predominance of

lamarckiana character in its rosettes, appears also to have the mutating constitution of *lamarckiana*.

The F_2 rosette of the lamarckiana type (*pycno* × *lam.*)—The complex of characters expressed in the rosette, derived from both parents, are such that it resembles neither parent. Still the preponderance of characters expressed in the rosette of the *lamarckiana* type of twin comes from *pycnocarpa*. These are the narrow, furrowed, noncrinkled, repand leaves, while the edge character comes from *lamarckiana*. The leaves are light green. It is a striking rosette and the uniformity throughout the entire row was remarkable (see Fig. 2, Pl. I).

The F_2 rosette of the lamarckiana type of the reciprocal cross (*lam* × *pycno*).—Its resemblance to the rosette of the *lamarckiana* type of *pycno* × *lam* is remarkable. The only observable difference is that there is a slight buckling of some of the leaves, a *pycnocarpa* character. In both of these *lamarckiana* types the uniformity of the rosettes in the row was remarkable.

Reciprocal Crosses of Œnothera franciscana and pycnocarpa.

Cultures of 1915; Annual.

Œnothera pycnocarpa × *Œ. franciscana* (*No. 100*).—In this culture there were between 170 and 180 individuals. The majority reached maturity, but there were a few of the more tardy ones which formed autumn rosettes. Several of the latter began stem development and advanced far enough so that the rosette types could be correlated with the types presented by the mature plants in which the mature rosette stage was omitted. In the F_1 the progeny splits into two distinct types, corresponding to twin hybrids in the sense of deVries.

Pycnocarpa Type; Rosette.—The rosette of the *pycnocarpa* type is shown in Fig. 4, Pl. II., at the right. The *pycnocarpa* character is shown in the strongly toothed, partially cut margin of the basal portion of the leaves. This rosette is not so large nor so well furnished with leaves as those of the F_2 since the few plants of 1915 annual culture which did not form stems, were belated and did not form such fully mature rosettes.

Pycnocarpa Type; Mature Plants.—There were 13 mature or nearly mature plants of this type in the culture. They were approximately 1⅓ m. high (about 130 cm.). All of the red color, except the sunburn comes from the *franciscana* parent, as well as the large size of the flowers. The stems are green with a rather strong tinge of red in streaks, but parts exposed to the sun usually become quite red. Red tubercles are present on the stem, branches and ovaries. The lower branches over the base of the stem are 50–60 cm. long. The flowering branches occur from the middle upward. The leaves over the middle portion of the stem are nearly like those of *pycnocarpa,* long, narrow, furrowed, drooping and strongly serrate on the edges, but the midveins are pink. The foliage is dark green. The calyx buds are 3–3.5 cm. long by 6 mm. broad at the base, slightly tapering from the base to the base of the tips, then abruptly or gradually, and with considerable red color in longitudinal bands. When open, the flower spread is 4.5–5 cm. The petals are obovate, strongly emarginate, pale lemon yellow, 20 mm. long by 25 mm. broad. The stamens overlap and nearly reach the tips of the stigmas, or do not quite reach the base of the stigmas. The pods are 3.5 cm. long by 6–7 mm. broad at the base, tapering gradually and evenly to the apex.

Franciscana Type: Rosette.—An F_1 rosette of the *franciscana* type is shown in Fig. 5, Pl. III, left hand, a belated plant of the 1915 culture. The rosettes of the *franciscana* type are very difficult to distinguish from those of *franciscana* itself. In fact I do not believe that I could distinguish them. It is clearly distinguished, however, from its twin, the *pycnocarpa* type of the same cross, at the right hand, Fig. 6, Pl. III. The leaves of this rosette are narrower than the mean, for rosette leaves of *Œ. franciscana,* or for this twin hybrid *franciscana* type, but as this rosette is a belated plant the leaves have not reached their full sizes.

Franciscana Type: Mature Plants.—There were 153 mature plants of this type in the cross. They measure approximately 1 m. high (90–120 cm.). The stems are green with occasionally a faint tinge of pink over the older portion. Red tubercles are present on the stem, branches and ovaries. The fruiting spike is 40–50 cm. long, the bracts long, green, persistent, the lower ones up to 9 cm.

long by 3 cm. broad. The calyx buds are 3–3.5 cm. long by 7–8 mm. broad at the base, tapering gradually to the apex, usually an abundance of red color in the calyx, sometimes with only a faint tinge. The open flowers are 4.5–5 cm. broad, the petals narrowly obovate to cuneate with gaps between them at the base, 20–25 mm. long and broad in the larger flowers. The stamens do not quite reach the base of the stigma, and the stigmas are more slender and longer than in the *pycnocarpa* type. The flowers are more delicate and wilt earlier than those of the *pycnocarpa* type. Pods 4–4.5 cm. long by 7 mm. stout at the base. The leaves are exactly like those of the parent *franciscana,* narrow, long, only slightly furrowed, toothed on the edges, not so drooping as in the *pycnocarpa* type, plane, midvein white, foliage pale green contrasting strongly with the dark green foliage of the *pycnocarpa* type.

The fruiting spikes in these annual F_1 cultures also show a distinct splitting into two types in regard to the length of the spike or fruiting axis.

Œnothera franciscana × *pycnocarpa* (*No. 101*).—The reciprocal cross, *Œnothera franciscana* × *pycnocarpa* gives also a F_1 progeny which splits into two hybrid types. These types are identical with those just described from the cross *pycnocarpa* × *franciscana.* There were 102 plants of the F_1, 90 of these belong to the *franciscana* type and 12 to the *pycnocarpa* type. Here as in the reciprocal cross a preponderance of the progeny is of the *franciscana* type.

The F_2 Generations.

From the F_1 progeny of the crosses between *Œnothera franciscana* and *pycnocarpa,* seed was saved and sown from three of the hybrid types, the *pycnocarpa* type, and *franciscana* type of twin from the F_1 of *Œ. pycnocarpa* × *franciscana;* and from the *pycnocarpa* type of twin in the reciprocal cross. The cultures were carried along parallel with those of the F_2 described above, from crosses between *Œ. lamarckiana* and *pycnocarpa.* They were grown as biennials, and the rosettes were mature and fully developed in the autumn of 1916.

Pycnocarpa type F_2 No. 157 (*pycno* × *fran*).—There were 50

plants in the F_2 of this culture. The *pycnocarpa* type is not fixed in the F_1, but splits in the F_2 into two types, the *pycnocarpa* type and the *franciscana* type. Of the 50 rosettes in the culture, 13 were of the *pycnocarpa* type, and 37 of the *franciscana* type. The two types which result from the splitting of the *pycnocarpa* type in the F_2 are shown in Fig. 7 (=157.33), Pl. IV., *pycnocarpa* type; and in Fig. 8 (=157.10), Pl. IV., *franciscana* type.

Franciscana type F_2, No. 158 (*pycno* × *fran*).—There were 64 rosettes of this type in the F_2, all of the *franciscana* type. There is no splitting of the *franciscana* type in the second generation, but the fluctuating variations in the rosettes are quite marked. These variations relate to the size and shape of the leaves, and parallel the fluctuating variations of the leaves in the rosettes of the parent *Œnothera franciscana.*

Of the reciprocal cross (*Œnothera franciscana* × *pycnocarpa*), only the *pycnocarpa* type twin was grown in the F_2. There were 42 plants, most of them developed into mature, autumnal rosettes, but in a few premature stem development checked rosette development. Splitting in the second generation occurs here also. There were 39 rosettes of the *franciscana* type and 4 of the *pycnocarpa* type.

Fluctuating Variations in the F_2 Hybrid Types.—In the second generation in all of the hybrid types of the crosses between *Œ. franciscana* and *pycnocarpa* the fluctuating variations as shown by the rosettes were very marked. These variations were studied more carefully in the *franciscana* types. It was possible to recognize several groups into which the principal variations could be assembled, although the limits of variation in the several groups were not clear cut. The groupings are as follows:

Series No. 157, F_2 of *pycnocarpa* type (*pycno* × *fran*). In the splitting between the 50 plants in this culture there were 15 of the *pycnocarpa* type and 30 of the *franciscana* type. The groups of variation in the *franciscana* type, with the number of rosettes in each group, are as follows.

1. Leaves medium broad, dark green, white-veined, 3.
2. Leaves broad, dark green, crinkled, pink-veined, 17 (6 of them rather narrow leaved).
3. Leaves narrow, dark green, white-veined, 4.

4. Leaves broad, dark green, white-veined, 5.
5. Leaves narrow, pale or yellowish green, pink-veined, 6.
6. Leaves narrow, dark green, pink-veined, 2.

Series No. 156, F_2 of *pycnocarpa* type (*fran* × *pycno*). In the splitting between the 43 plants in this culture there were 4 of the *pycnocarpa* type and 39 of the *franciscana* type. The groups of variation in the *franciscana* type, with the number of rosettes in each group, are as follows:

1. Leaves broad, dark green, crinkled, pink-veined, 4.
2. Leaves broad, dark green, white-veined, 16.
3. Leaves medium broad, dark green, white-veined, 15.
4. Leaves narrow, pale green to yellowish, pink-veined, 3.
5. Leaves medium broad, pale green, white-veined, 1.

Series No. 158, F_2 of *franciscana* type (*pycno* × *fran*). There is no splitting of the *franciscana* twin in the F_2. There were 67 plants in the culture. The groups of variations in the rosettes of the second generation of the *franciscana* twin, with the number of rosettes in each group, are as follows:

1. Leaves broad, dark green, pink-veined, 9.
2. Leaves broad, dark green, white-veined, 14.
3. Leaves narrow, dark green, white-veined, 13.
4. Leaves medium broad, dark green, white-veined, 25.
5. Leaves narrow, pale green or yellowish olive green, 3.
6. Leaves narrow, pale green, pink-veined, 2.

Considerable fluctuating variations were presented by the rosettes of the *pycnocarpa* types in the F_2 of the reciprocal crosses. Parallel fluctuations undoubtedly occur in the rosettes of the F_1 of the two types of hybrids in the reciprocal crosses, but as the F_1 plants grown were nearly all annuals the number of rosettes was not sufficient for a study of these variations in the first generation. Since the rosettes of *Œnothera pycnocarpa* are very uniform, the pronounced fluctuating variations in the hybrids of the crosses between *pycnocarpa* and *franciscana* are traceable to the constitution of *Œ. franciscana,* for the fluctuating variations in the rosettes of the *franciscana* hybrid type are parallel with the fluctuating variations in the rosettes of *franciscana* itself. In the 1916 cultures, 135 rosettes of *Œ. franciscana* were grown in the garden as a parallel

culture. Five or six different groups were recognized, but no record was kept of the number of rosettes which could be assigned to each group. The groups are as follows:

1. Leaves broad, dark green, plain, white-veined.
2. Leaves broad, dark green, crinkled, white-veined.
3. Leaves narrow, dark green, red-veined.
4. Leaves, broad, dark green, red-veined.
5. Leaves medium broad, dark green, white-veined.

These marked fluctuating variations in leaf form, representing one of the features in the constitution of *Œnothera franciscana* which is inherited in its hybrid progeny, marks this species as a favorable one for stimulating great fluctuating variations in the hybrids from crosses with other species, indicated not only by the crosses of *Œnothera franciscana*[3] and *pycnocarpa* described here but also by the great fluctuating variations resulting from crosses between *Œnothera franciscana* and *Œ. biennis* as described by Davis (1916).

The marked fluctuating variations in the twin hybrids of the reciprocal crosses between *Œ. franciscana* and *Œ. pycnocarpa* might be interpreted by some as indicating that two distinct hybrid types were not present, but that the two forms represent merely a single, wide range of fluctuating variation. That this interpretation is not valid is shown by the fact that the *franciscana* twin type, although variable, is fixed, it does not split in the second generation nor in its fluctuations does it produce typical *pycnocarpa* twin forms; while the *pycnocarpa* twin type splits in the second generation into the two types.

Further evidence that the interpretation given, in this paper, to the results of these crosses, so far as the production of twin hybrids, and one-sided splitting is concerned, is admissible, is found in the very close genetic relation which *Œnothera franciscana* bears to *Œnothera hookeri* (see Bartlett, 1914, p. 33). Reciprocal crosses of *Œ. hookeri* with *Œ. lamarckiana,* or with certain of its mutants,

[3] The seed of *Œnothera franciscana* which I have used came from Dr. H. H. Bartlett in the winter of 1914, from a series of cultures which he had continued for a few years, and as I understand it has the same pedigree as the seed employed by Dr. Davis in his interesting crosses with *Œ. biennis.*

give twin hybrids in the first generation, with splitting of one of the twins in the second generation (de Vries, 1913, p. 131). The results of reciprocal crosses of *Œ. franciscana* with *Œ. pycnocarpa* are a close parallel, and indicate that the genetic constitutions of *Œ. franciscana* and *Œ. hookeri* are very similar.

Summary and Conclusion.

The history of the progeny of the crosses of *Œnothera lamarckiana* and *Œ. franciscana* with *Œ. pycnocarpa* belongs in the series of some of the most interesting phenomena of hybridization known in the Œnotheras, and discovered by de Vries (1907, 1908, 1909, 1913). These phenomena are, first, the production of twin hybrids in the first generation of a cross, the two hybrids being fixed in the F_1 generation and continuing to reproduce themselves in the F_2 and succeeding generation; and, second, the production of twin hybrids in the F_1 with one-sided splitting in the F_2, and succeeding generations. In the second case one of the twin hybrids of the first generation is fixed in the F_1, the other splits in the F_2, into two types, like the twins of the F_1, one of which is fixed while the other splits in the F_3 and so on. In the crosses of *Œnothera lamarckiana* and *Œ. franciscana* with *Œ. pycnocarpa,* the cultures have not been carried beyond the second generation. But the existence of this peculiar phenomenon of inheritance in certain crosses among the evening primroses has been so thoroughly demonstrated by de Vries for several succeeding generations that there can be no reasonable doubt that it applies also to the behavior of the crosses here described, for succeeding generations.

In the reciprocal crosses of *Œ. lamarckiana* with *Œ. pycnocarpa* the twin hybrids are fixed in the first generation, and "breed true" in the second, and in all probability, in succeeding generations. Each of the twin hybrids is very uniform, at least in the rosette stage, and shows a minimum of fluctuating variations. The *pycnocarpa* twin type is a physiological homozygote but its fundamental heterozygotic constitution is now and then manifested by the saltatory production of *lamarckiana* forms, and also of forms approaching *pycnocarpa,* or the *lamarckiana* twin type. The reaction system

established in the F_1 zygote which produces the *pycnocarpa* twin type, is in a very high percentage of cases stable in the F_2 and the following generations. But occasionally other reaction systems, usually dormant, are activated, resulting in *lamarckiana,* and other forms. The *lamarckiana* twin type presents also a minimum of fluctuating variations in the rosette stage, though it appears to me probable that it is a physiological homozygote and carries in a latent, or inactive condition the other factors of both parents which are not manifest in the phænotype.

In the reciprocal crosses of *Œnothera franciscana* with *Œ. pycnocarpa,* only one of the twin hybrids (*franciscana* type) is fixed in the first generation.[4] The other (*pycnocarpa* type) having a "hybrid constitution" splits in the second generation into two types which are like the twins of the F_1. The *pycnocarpa* type with great probability would continue to split in the same way in succeeding generations. When the reaction systems of *Œ. franciscana* and *Œ. pycnocarpa* meet in egg or F_1 zygote, a new reaction system is established combining the factors of the two parents. In the unions certain factors of one or the other parent preponderate but their influence is modified more or less by the homologous factors. But the new reaction system established in the F_1 zygote is not the same in all the zygotes. As the two different parent reaction systems meet in the egg, one or the other of two new reaction systems is organized, and chance seems to determine which one of these working systems is established in a given zygote. The reaction system of the *lamarckiana* twin is stable, that of the *pycnocarpa* twin is unstable (and heterozygotic). The twin hybrids in these crosses display in the organization of their reaction systems in the F_1 zygote what I have termed "selective dominance" (Atkinson, 1917, p. 253).

I wish here to express my appreciation of aid given by Mr. H. E. Stork, assistant in botany, in writing notes in the field from my dictation, and for making some of the photographs.

[4] The *franciscana* twin probably carries the *pycnocarpa* factors also, but in a subordinate or permanently latent condition. If so, it is a physiological homozygote. If it were possible to introduce a splitting factor into the *franciscana* twin by an appropriate cross, and cause the *pycnocarpa* character to reappear in some of the progeny, it would indicate the fundamental heterozygotic constitution of the *franciscana* twin.

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